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MAE 342 KINEMATICS & DYNAMICS OF MACHINERY
EXAM 2 Practice Questions

Name: _____ You are allowed two sheets of notes.

1. Compute the theoretical mobility of each of the following mechanisms. Indicate clearly in your calculations the number of links and number of joints having each number of degrees of freedom.

Planar Mechanisms

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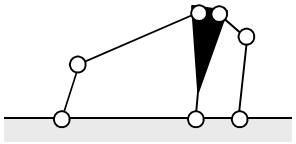
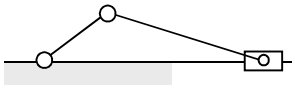
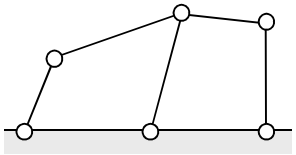
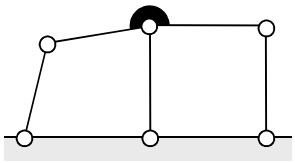
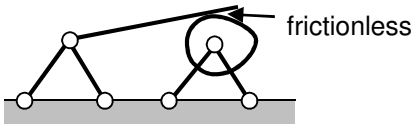
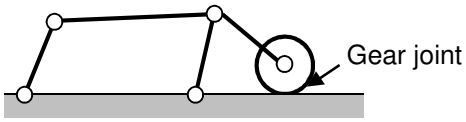




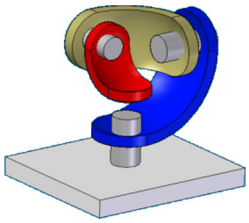


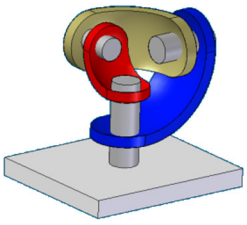






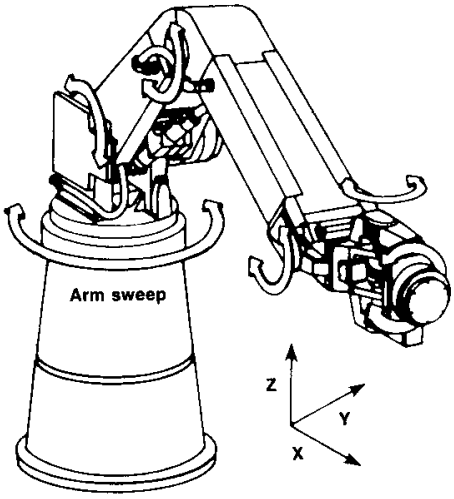
Spherical Mechanisms





Spatial Mechanisms

For the robot shown, note that there are six revolute joints (shown by the circular arrows) that are connecting the links in series.



In the scissor jack shown, note that there are two gear joints where the two top diagonal links meet and where the bottom two diagonal links meet. Note also that the threaded rod attaches to two hidden blocks via a screw joint on one and a revolute joint on the other. Ignore the handle piece.

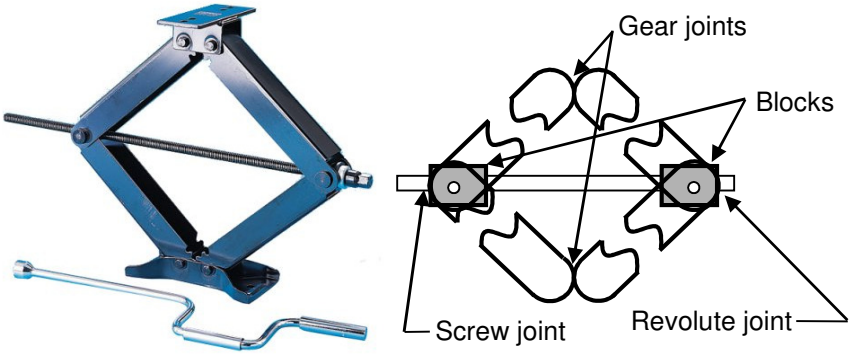


Image from Camco.

Image from web site of All Points North Model Railroad club

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2. For the steam locomotive shown create a viable schematic drawing showing how the linkage probably works to drive the wheels from the piston/cylinder.
   - Treat the mechanism as a planar linkage with only revolute and sliding (prismatic) joints.
   - Treat the locomotive itself as the frame.
   - Label all joints and links in the schematic drawing as well as in the lightened figure below.

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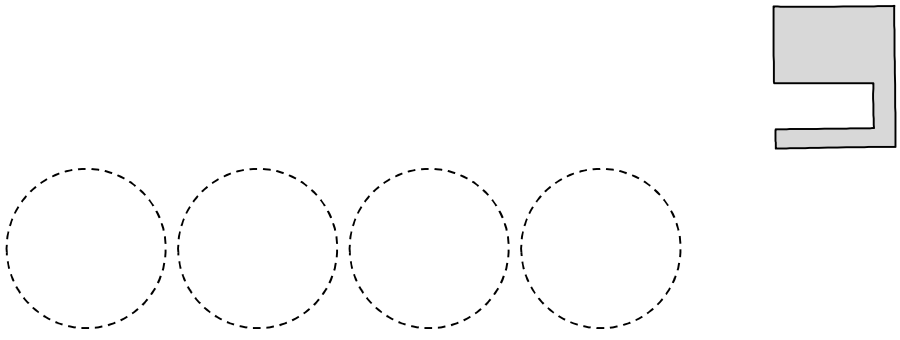
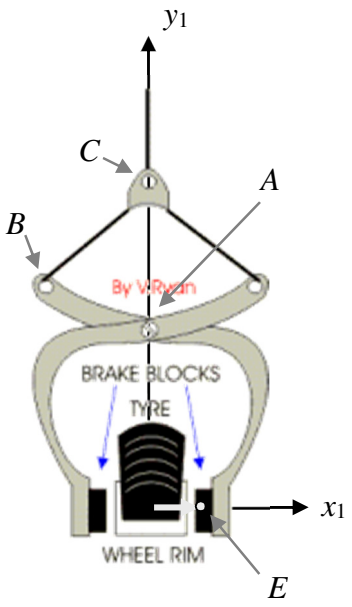


3. Set up the mechanism analysis for the bicycle brakes shown:

   a) Create a schematic drawing of the mechanism.
      - Do only the half of the mechanism given by points *A*, *B*, *C*, and *E*.
      - Use a slider to represent the portion at *C*.
      - Label all joints and links.

   b) Sketch the vectors for the loop closure equations.
      - Label all vectors.

   c) Show the steps of the solution procedure by writing out the loop closure equations for each step.
      - Assume that $\mathbf{R}_C$ and $\mathbf{R}_A$ are fully known and $\mathbf{R}_E$ is completely unknown.
      - Use '✓' check and '?' question marks to identify known and unknown magnitudes and directions.
      - Indicate which of the four solution cases is being solved.
      - You do not need to solve anything.



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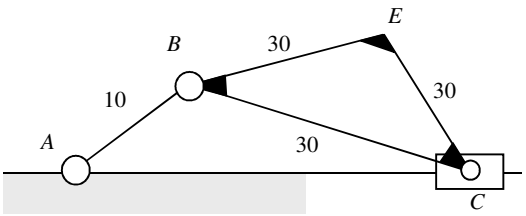
4. Perform a graphical analysis to trace the locus of a point on the coupler of a crank-slider mechanism:
   a) Using a ruler and compass, draw the mechanism position for 8 input angles: 0, 45, 90, 135, 180, 225, 270, and 315 degrees.
   b) Sketch the approximate path of the coupler point *E* (see figure).
      - Use dimensions given in the figure.
      - Figure is not drawn to scale.
      - Dimensions in inches are shown for each link length.



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5. Calculate the missing magnitudes, directions, and Cartesian components for the planar vector equation: $\bar{R}_A + \bar{R}_{BA} + \bar{R}_{CB} = \bar{R}_C$. Be sure to sketch any vector equations. Make sure that the computations and sketch agree. All distances are in inches and angles in degrees.

Vector	Magnitude	Direction	X-component	Y-component
$\bar{R}_A$			0	0.5
$\bar{R}_{BA}$	2	45		
$\bar{R}_{CB}$	5			
$\bar{R}_C$		0		

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Problem 5 cont'd.

6. Calculate the missing magnitudes, directions, and Cartesian components for the planar vector equation: $\bar{R}_{BA} + \bar{R}_{CB} + \bar{R}_{DC} + \bar{R}_{AD} = \bar{0}$. Be sure to sketch any vector equations. Make sure that the computations and sketch agree. All distances are in mm and angles in degrees.

Vector	Magnitude	Direction	X-component	Y-component
$\bar{R}_{BA}$	40	60		
$\bar{R}_{CB}$		330		
$\bar{R}_{DC}$			-10	-20
$\bar{R}_{AD}$		185		

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Problem 6 cont'd.